United States
Department of
Agriculture

Forest Service
Intermountain Region
Ogden, Utah

A Pilot Project with Orthene® for Control of the Western Spruce Budworm McCall, Idaho 1977

In Cooperation with the State of Idaho
Department of Lands and the
Boise Cascade Corporation

COVER STORY

Bell 206 Helicopter spraying Orthene® with Rhodamine Red dye to track spray droplets to insure uniform coverage for suppression of western spruce budworm.

USDA Forest Service

State of Idaho

Boise Cascade Corporation

A Cooperative Pilot Project to Evaluate
Orthene Forest Spray for Control
of the Western Spruce Budworm,
Choristoneura occidentalis Freeman (Lepidoptera:
Tortricidae). McCall, Idaho

1977

Forest Service, USDA
State of Idaho
Boise Cascade Corporation

by

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ABSTRACT

In cooperation with the State of Idaho and the Boise Cascade Corporation, Region 4 of the Forest Service, USDA, conducted a pilot control project in central Idaho to determine the effectiveness of Orthene applied at ½ lb AI/acre when used under operational conditions against the western spruce budworm, *Choristoneura occidentalis* Freeman. Eight blocks of approximately 1,000 acres each were selected in areas of known budworm infestation on State, private and Federal lands in the area of McCall, Idaho. By a randomized procedure, four of these blocks were chosen as treatment areas and the remaining four were designated as check (untreated) areas. In each block, 25 three-tree cluster plots were selected from which population samples were collected.

Each block was released for spraying when 50 percent of the larvae were in the 5th and 6th instar. A prespray population sample was taken prior to treatment; postspray samples were collected at 3 and 10 days following treatment. All budworm populations were expressed as the number of budworm larvae per 100 buds. The spray mixture was applied by a Bell 206 helicopter equipped with 40 flat fan Tee Jet nozzles.

After treating, the four spray blocks had an average of 2.9 budworm per 100 buds and an unadjusted mortality of 91 percent for the 10-day postspray sampling period. The 10-day residual population of 2.9 had a 95 percent confidence interval of ± 1.6 (1.3 to 4.5) which satisfied one project objective—a residual population of less than 5 budworm larvae per 100 buds. Each of the four spray blocks were below 5 and ranged from 1.8 to 4.1. The 95 percent confidence interval for unadjusted mortality was 91 ± 7 (84 to 98) based on the four spray block means. The interval includes 95 percent which was a project objective; however, none of the four spray blocks had a mortality of 95 percent, but ranged from 84 to 94 percent.

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INTRODUCTION

The western spruce budworm, (*Choristoneura occidentalis* Freeman), is one of the most widely distributed and destructive forest defoliating insects in western North America (Carolin and Honing, 1972). A native pest, it was first discovered in the 1800's, then determined to be a serious enemy to forests in the western United States in 1922 when two outbreaks occurred in Idaho. Since that time, visible defoliation has been reported each year on at least one Ranger District in the Forest Service's Intermountain and Northern Regions (Johnson and Denton, 1975). Many outbreaks have been reported in the past 50 years causing serious damage to stands of Rocky Mountain Douglas-fir (*Pseudotsuga menziesii* var *glauca*), true firs (*Abies* spp.), Engelmann spruce (*Picea engelmannii*), and western larch (*Larix occidentalis*) (Johnson and Denton, 1975).

The present outbreak of western spruce budworm in Idaho began in 1968 on the Payette National Forest near the town of McCall. The infestation, which now occurs over 900,000 acres of mixed conifer type, also includes portions of the Boise National Forest, State, private and other Federal lands (Knopf, et al., 1977). This area was selected for the project due to the long history of budworm activity and the recent buildup in budworm populations. Egg mass data collected during 1976 on the Payette National Forest indicated the population would be heavy enough to cause moderate to heavy defoliation throughout most of the area during 1977.

During extensive outbreaks the accepted method of control has been to aerially apply chemicals against the feeding larvae. Such programs were first initiated in the northwest United States in 1948 using DDT. By the early 1960's, DDT began to be replaced by more environmentally acceptable chemicals and was eventually banned in 1972. Malathion was one of the replacements which was tested and eventually registered (USDA, 1974) but is generally considered unacceptable due to unpredictable mortality. Zectran has also been registered for control of this pest, but was lost as a control agent when the manufacturer discontinued its production for forest use in 1974 (Markin).

The insecticide acephate (Orthene Forest Spray, manufacturer Chevron Chemical Co.) has recently been field tested against numerous forest defoliating insects including the gypsy moth, *Porthetria dispar* (L.); the elm spanworm, *Ennomos subsignarius* (Hübner); the elm leaf beetle, *Pyrrhalta luteola* (Muller); the eastern spruce budworm, *Choristoneura fumiferana* (Clemens); a hemlock looper, *Lambdina athasaria athasaria* (Walker); and the Douglas-fir tussock moth, *Orgyia pseudotsugata* (McDunnough) (Markin). In 1975 field tests conducted by the Forest Service against the western spruce budworm at 1 lb AI/gallon/acre showed very good results. In 1976 additional testing showed that Orthene at ½ lb AI/acre produced a mortality rate that was not significantly different from the 1 lb AI/acre rate (½ lb/acre = 93.0 percent mortality; 1 lb/acre = 98.8 percent mortality) (Markin). Encouraged by these results and as part of the Forest Service's continuing effort to have several insecticides available for controlling forest defoliating insects, the decision was made to evaluate a reduced dosage of Orthene in a pilot control project simulating operational procedures. Accordingly, in late June and early July of 1977, the Forest Service, Region 4, in cooperation with the State of Idaho and Boise Cascade Corporation, aerially sprayed approximately 4,000 acres of Federal, State and private lands in the vicinity of McCall, Idaho using Orthene

applied at ½ lb AI/acre as a control agent for the western spruce budworm.

OBJECTIVES

1. To compare the operational efficacy of Orthene applied at ½ lb AI/acre with results of the past Orthene field tests.
2. To identify operational problems associated with using Orthene.
3. To determine the unit cost of operational use of Orthene applied at ½ lb/acre.
4. To reduce the population of western spruce budworm in the treated areas by 95 percent and have a residual population of no more than 5 larvae/100 buds.

PROJECT AREA

DESCRIPTION

The project was conducted in the vicinity of McCall, Idaho on the Payette National Forest and other adjacent lands. The project area extended from Brown Creek, New Meadows District, on the north to Paddy Creek, McCall Ranger District, on the south. Within this area, eight 1,000-acre blocks were selected within mixed conifer stands on ownership consisting of Forest Service, Bureau of Land Management, State of Idaho, Boise Cascade Corporation and other private lands (Figures 1 and 2).

The stand composition within each block was predominantly grand fir and Douglas-fir; the balance being subalpine fir, ponderosa and lodgepole pine.

INSECTICIDE

DESCRIPTION

Orthene Forest Spray (O, S-Dimethyl acetylophosphoramidothicate) is an organophosphate insecticide. Other names for the compound are Ortho 12 420, RE 12, 420 ENT 27822 Ortran and acephate. It is a white crystalline solid, with melting points of 92-93^{o}C (pure) and 82-89^{o}C (technical). The specific gravity is 1.35 (technical). The solubility is high in water (approximately 65 percent); relatively low in organic solvents (less than 5 percent in aromatic solvents; over 10 percent in acetone and alcohol). It is relatively stable. Volatility is low, 1.7×10^{-6}mm Hg (24^{o}C) (Chevron, 1976). The molecular weight is 183.16. Shelf life is approximately two years (Orthene 75S). Orthene is relatively stable with respect to hydrolysis. In the pH range 5 to 7, the half-life is about 50 days at 21^{o}C and about 20 days at 40^{o}C. At 21^{o}C the half-life at pH 3 is 65 days and at pH 9, 16 days (Chevron, 1975).

Orthene is primarily a contact and stomach insecticide of moderate persistence with residual systemic activity of approximately 1-15 days at suggested foliage use rates (Chevron, 1976).

FORMULATION, HANDLING AND TANK ANALYSIS

The Orthene was formulated in water at ½ lb AI/gallon for application to one acre. Chevron Chemical Company furnished the insecticide in seven-gallon plastic buckets with plastic lids, each of which contained two 10-lb bags of Orthene 75S-Forest Spray.

For this project the spray was formulated each morning prior to spray operations. This was done to minimize the potential for Orthene to settle when mixed in large quantities, and because the budworm development on the four plots could not be relied on to occur in four consecutive days. Formulation of the 1,000-gallon batches started at approximately 2:30 a.m. and was completed by 5:00 a.m. Due to short ferry distances, the nurse tanker was at the base heliport no later than 5:30 a.m. each spray day.

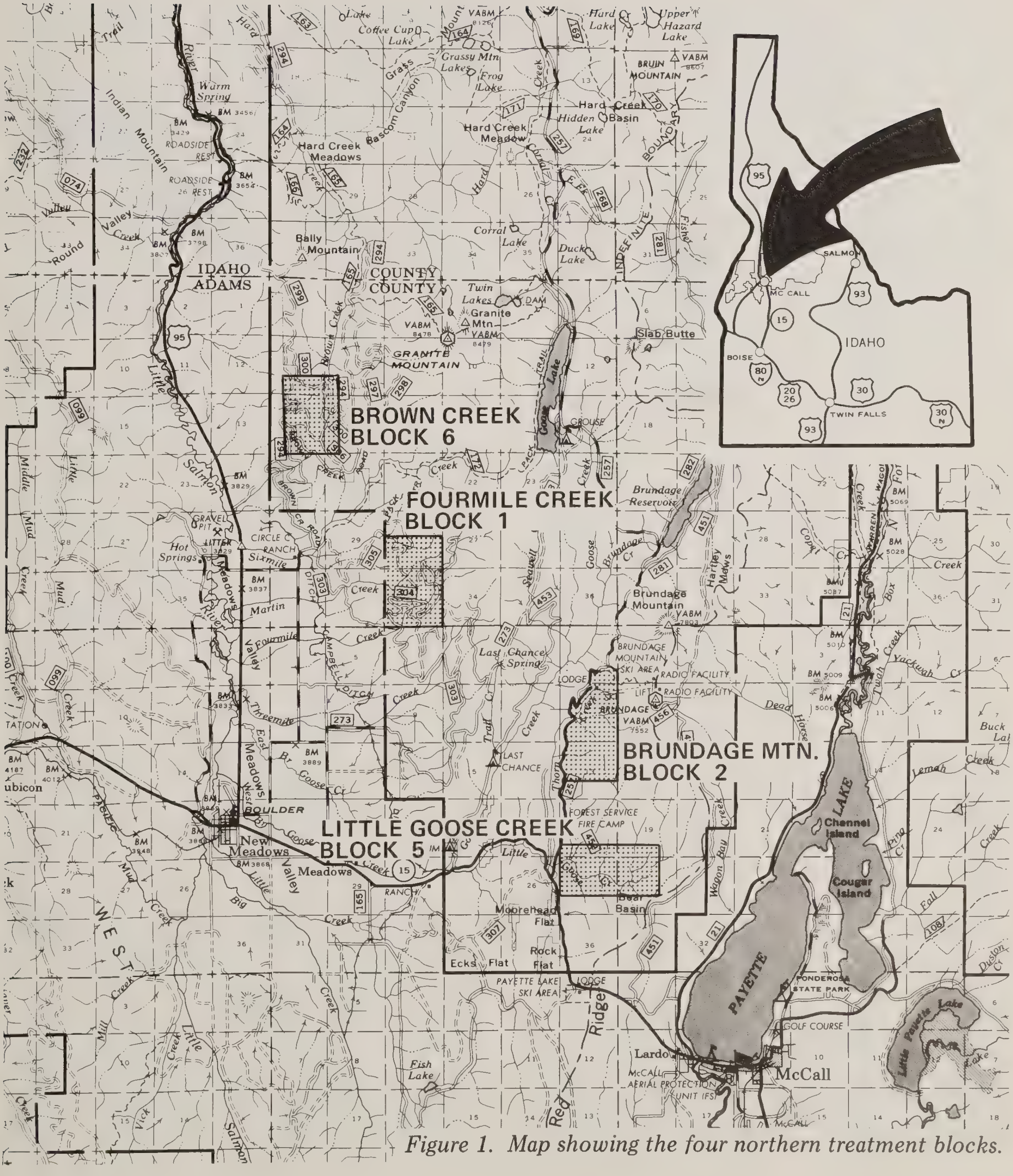

Figure 1. Map showing the four northern treatment blocks.

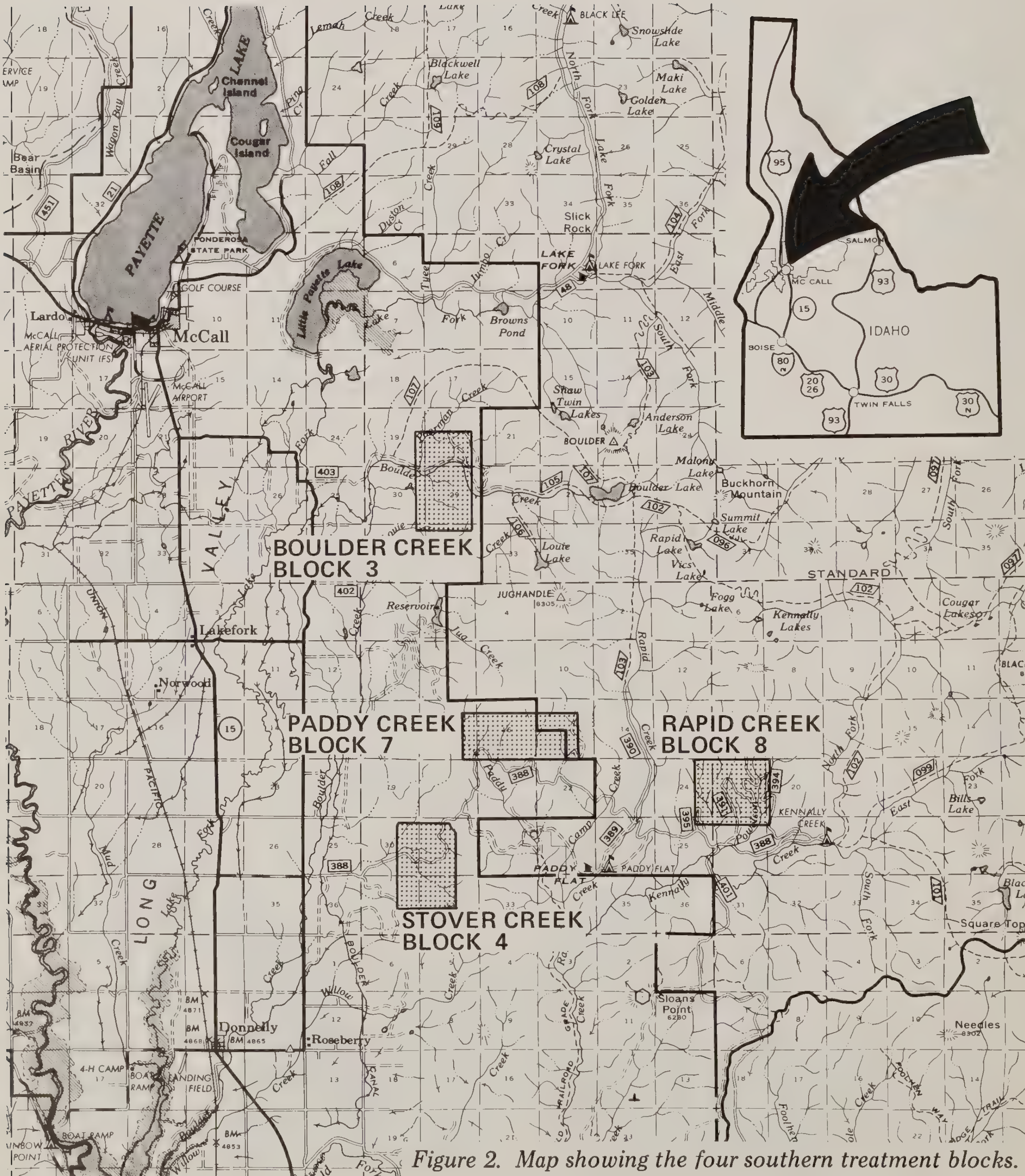

Figure 2. Map showing the four southern treatment blocks.

Formulation consisted of mixing, with bypass agitation, 67 10-lb bags of Orthene into 920 gallons of water to yield ½ lb AI/gallon of formulated spray. To avoid contaminants, clean water was drafted from the top two feet of a 13,000-gallon holding tank situated at the McCall aerial tanker base. After the Orthene was mixed, Rhodamine B dye was added to make a concentration of .3 percent. Liquid dye was used on three blocks—Fourmile, Stover, and Boulder. Powdered Rhodamine B Extra was used for the Brundage spray block.

Table 1. Orthene 75S Forest Spray Tank Spray Analysis.

Block Name	Sample	Sample Results[1]	Percent Recovery
		Lb/Gal.	
Brundage Mt.	1	.635	126.8
" "	2	.678	135.5
Boulder	1	.655	131.0
"	2	.685	137.0
Stover Cr.	1	.655	131.0
" "	2	.682	136.4
Fourmile Cr.	No Sample		

[1] All treatments were formulated to 0.5 lb/gal.

Paired tank samples were taken from freshly mixed batches just prior to loading into the spray aircraft. Gas chromatograph analysis (Table 1) showed a consistently high formulation and percent of recovery for all batches analyzed. Even though the formulations and percent recoveries were higher than expected, results were consistent. One reason for the high recovery is that the Orthene Forest Spray for this project came from a special batch that was formulated at 80.25 percent AI rather than the 75 percent AI guaranteed minimum (Chevron Chemical Co., personal communication). A separate analyses of the delivered concentrate conducted six months following termination of the project showed 79.62 percent AI confirming the higher rates. This difference, however, would not account for all of the increase in recovery found. Another source of variation could have been a machine calibration error when the gas chromatograph analyses were made.

STORAGE AND DISPOSAL

Arrangements were made with the Payette National Forest to store the Orthene in a warehouse at the McCall Ranger District. The storage bay was partitioned off with ¾-inch plywood paneling and had a lockable door. Appropriate warning signs were posted and care was taken that no foodstuffs were placed adjacent to the storage area.

After formulating was completed each day, the empty bags were put back into the empty buckets, the buckets were resealed and returned to the locked storage bay. At the end of the project the buckets were split with an axe and taken, with the enclosed bags and disposable protective clothing used by the formulators, to an insecticide approved dump southeast of McCall. They were then placed in a trench and covered with soil.

EXPERIMENTAL USE PERMIT

Chevron Chemical Company applied for and received an extension of their Experimental Use Permit No. 239-EP-79 for Orthene Forest Spray. The extension period was from May 11, 1977, to May 11, 1978.

PROJECT DESIGN

GENERAL

This project utilized a completely randomized design. Eight blocks were selected each having similar characteristics—size, previous defoliation history, proximity to each other, elevation, and expected budworm larval densities.

Treatments:	two treatments were used in the project-treated (sprayed) and untreated (checks).
Replications:	four replications were used for each of the two treatments.

The assignment of the two treatments and four replications to the eight blocks was made at random.

SAMPLING DESIGN

A sampling scheme was established for each block to ensure a reliable estimate for each sampled characteristic. The sampling unit within each block was a cluster.

Clusters:	twenty-five clusters were selected within each block. Three trees in close proximity to each other constituted a cluster.

The observational units sampled and summarized at the cluster level consisted of the following variables:

1. Prespray budworm larvae per 100 buds.
2. Three-day postspray budworm larvae per 100 buds.
3. Ten-day postspray budworm larvae per 100 buds.
4. Prespray defoliation index expressed as the percent defoliation of the new shoots.
5. Ten-day postspray defoliation index, expressed as the percent of defoliation of the new shoots.
6. Egg masses per square meter of foliage.

The cluster level variables were computed in the following manner:

1. Budworm larvae per 100 buds.

$$\text{Yijk} = \left[\sum_{e=1}^{\text{No. trees}} \left(\frac{\displaystyle\sum_{m=1}^{\text{No. branches}} \frac{(\text{budworm larvae})\ em}{(\text{buds})\ em}}{(\text{No. of branches})_{e}} \right) \right] \Big/ (\text{No. of trees})$$

The number of branches sampled per tree was two for the prespray and four for the two postspray sampling periods. There were three trees sampled in each cluster. Yijk represents the budworm larvae per 100 buds for the k^{th} cluster in the j^{th} block in the i^{th} treatment.

2. Defoliation index.

$$\text{Yijk} = \left(\sum_{m=1}^{\text{branches}} (\text{Defoliation Index})\ m \right) \Big/ (\text{No. of branches})$$

The number of branches sampled per tree was two for the prespray and four for the postspray. Only one tree from a cluster was used.

3. Egg mass per meter squared.

$$\text{Yijk} = \left(\sum_{m=1}^{\text{branches}} \left(\frac{\text{No. of Egg mass}}{\text{area}} \right) \right) \Big/ (\text{No. of branches})$$

Two branches were used to determine egg mass densities from each of the three cluster trees.

ANALYSIS DESIGN

Block means and standard errors were computed for each block and for each sampled variable. The form used for those calculations is:

1. Block mean

$$Y_{ij} = \left(\sum_{k=1}^{M_{ij}} Y_{ijk} \right) \Big/ M_{ij}$$

where Mij is the number of clusters in each block (usually 25).

2. Block standard errors.

$$S.E.\, y_{ij} = \sqrt{\frac{\sum Y_{ijk}^2 - (\ Y_{ijk}\ )^2}{M_{ij}\,(\ M_{ij} - 1\ )}}$$

The analysis of variance and covariance model and computational procedures used are:

Analysis of Variance Model

$Y_{ijk} = \upsilon + T_i + \varepsilon_{ij} + M_{ijk}$, where

1. M_{ijk} is the sampling error term due to sampling within each block.
2. ε_{ij} is the experimental error term between blocks.
3. T_i is the effect due to treatments (treated and untreated blocks).
4. υ is the effect of the overall mean.
5. Y_{ijk} is the observational unit (budworm per 100 buds, defoliation, or egg mass per meter^2).
6. i = 1, 2 treatments.
7. j = 1, 2, 3, 4 replications.
8. k = 1, 2 . . . 25 clusters within each block.

Analysis of Covariance Model

$Y_{ij} = \mu + T_i + B(X_{ij} - \mathbf{X}_{..}) + \epsilon_{ij}$, where

ϵ_{ij} is the experimental error between plots,

$\mathbf{X}_{..}$ is the overall experiment mean of the covariate (pre-spray population level),

X_{ij} is the value of the covariate for the j^{th} replication and i^{th} treatment,

B is the overall regression coefficient,

T_i is the effect due to treatments,

μ is the overall mean, and

Y_{ij} is the value of the dependent variable for the j^{th} replication in the i^{th} block.

Subsampling within each block was not part of the above model. The means of X_{ij} and Y_{ij} for each block were used in the analysis. The analysis is standard following Chapter 15 of Steel and Torrie (1960).

The analysis of covariance is used in this case primarily to obtain adjusted treatment means. The adjusted means are used to calculate the insect mortality for treated blocks only (excludes natural mortality).

An analysis of variance table showing the expected mean square and algebraic computation follow:

Analysis of Variance

Source	d.f.	s.s.	m.s.	Expected Mean Square
Treatments	t-1	SS_t	$SS_t/(t-1)$	$\sigma^2 + s\sigma_\varepsilon^2 + rs\Sigma\tau_i^2/(t-1)$
Experimental Error	t(r-1)	SS_{ee}	$SS_{ee}/t(r-1)$	$\sigma^2 + s\sigma_\varepsilon^2$
Sampling Error	tr(s-1)	SS_{se}	$SS_{se}/tr(s-1)$	σ^2
Total	trs-1	SS_{tot}	–	–

Source	Computations for Sums of Squares	
Between Plots	$\frac{\Sigma_i\Sigma_j x^2_{ij.}}{s} - \frac{x^2_{...}}{srt}$	$= SS_{plot}$
Treatments	$\frac{\Sigma_i x_i^2{}_{..}}{s} - \frac{x^2_{...}}{srt}$	$= SS_t$
Total	$\Sigma_i\Sigma_j\Sigma_k x^2_{ijk} - \frac{x^2_{...}}{srt}$	$= SS_{tot}$
Experimental Error	Plot S.S. - Treatment S.S.	$= SS_{ee}$
Sampling Error	Total S.S. - Plot S.S.	$= SS_{se}$

The F test for testing differences between treatments is computed by $M.S._t/M.S._{se}$ with (t-1) and t(r-1) degrees of freedom.

FIELD OPERATIONS

SAMPLING UNIT SELECTION AND MARKING

Based on field and aerial survey data collected in 1976, eight blocks were located and mapped in areas with moderate to heavy defoliation predicted for 1977. Boundary adjustments, to make 1,000-acre blocks, were made following a pretreatment survey designed to evaluate budworm larval population density, host type, topography, and access. The final boundaries were transferred to both large-scale topographic maps and aerial photograph enlargements. To help locate the plots in the field, plastic flagging was used to mark boundaries where they crossed major roads. For aerial purposes, block corners were marked with large fluorescent cloth or plastic panels. These were placed in tree tops with a line-throwing gun or dropped from a low-flying helicopter.

Prior to the spray date the 25 clusters were established within each of the eight treatment blocks and numbered consecutively 1-200. Each cluster of three host trees was carefully selected to provide a convenient sampling point. Clusters were distributed throughout each block in order to sample the variation in elevation, aspect, and type. To avoid boundary and dust problems, clusters were placed at least 2 chains from block boundaries and dusty roads.

Cluster information and location were recorded on field forms (Appendix 1) and marked on 7½ minute topographic maps. Revisits to each cluster were guided by these maps and aided by plastic flagging marking the way from the road to the site.

Sample trees selected within each cluster were open-grown Douglas-fir or grand fir 35 to 60 feet tall with full crowns and previous defoliation between 15 and 90 percent. The optimum defoliation in the project plan was 25 percent or less, but in some areas defoliation was too heavy to find trees within this range. The location of the cluster trees was mapped and each tree was marked with an aluminum tag on the bole and plastic flagging on the lower branches. The tags contained the block number (1 to 8), cluster number (1-25, 26-50, 51-75, etc.) and tree number (1 to 3).

Individual branch samples were taken from the midcrown of each tree at the cardinal directions. Using a telescoping pole pruner, branches were cut as near to 45cm in length as possible with the actual length and width measured in the laboratory.

LARVAL DEVELOPMENT SAMPLING

In order to apply the insecticide at the stage when the larvae were most vulnerable, blocks were released for treatment when 50 percent of the larvae were in the 5th and 6th instars. Independent larval development samples were taken from each block to determine the proper timing. The samples were collected every two days during the early stages of development, and daily when development approached the release stage.

Within each block, ten 2-tree plots were established using the same criteria used for clusters. Two 45cm branches were cut from opposite sides from the midcrown of each tree. These branches were individually bagged with appropriate identification tags (Appendix 2) and transported to the field laboratory for examination. Development sampling began shortly after bud burst and continued until each respective block was released for treatment at which time the prespray population sample was collected.

PRESPRAY AND POSTSPRAY SAMPLING

Prespray and postspray population samples were taken to measure the population density of budworm larvae before and after treatment. For the prespray sample, two 45cm midcrown branches were removed from the north and east quadrants from each of the cluster trees. Branches were individually bagged with an appropriate identification tag (Appendix 3) and transported to the field laboratory for examination.

Two postspray population samples were collected, one at 3 days and the other at 10 days following treatment. These samples were taken from the same cluster trees used for the prespray sample using the same techniques except four branches were taken; one from each quadrant of the tree. Again branches were bagged individually with identification tags (Appendix 4 and 5) and taken to the field laboratory.

SPRAY DEPOSIT ASSESSMENT

An assessment was made by measuring the amount of spray material deposited on Kromkote® cards placed within each spray block. Rhodamine dye, added to the spray mixture during formulation, made the spray droplets visible on the deposit cards. Six cards were located at each cluster. Prior to spraying, four 2 x 2-inch wooden stakes were placed around one tree in each cluster. These stakes were located at the drip line to hold the deposit cards about 1½ feet off the ground. Two additional stakes were placed in openings near each cluster. These openings were at least as wide as the height of the trees.

Each morning prior to spraying, plastic card holders were stapled to the top of each stake and the deposit card was inserted in the holder. Following application, the cards were allowed to dry for ½ hour before they were collected.

DEFOLIATION ASSESSMENT

Defoliation estimates were made before and after treatment to determine the amount of foliage saved in treated blocks as compared to untreated blocks. Defoliation data were recorded from the same branches taken for the prespray and 10-day postspray population samples.

EGG MASS SAMPLING

In conjunction with a yearly egg mass survey conducted on the Payette National Forest by the Boise Field Office, Forest Insect and Disease Management, all of the project clusters were revisited for egg mass samples. The primary purpose was to help determine how quickly and to what degree the budworm population in adjoining areas would reinvade treated areas. Procedures used for the project clusters were the same used for the annual egg mass survey. From each cluster tree, two 70cm branches were cut from opposite sides at midcrown and bagged individually. These branches were later examined in the laboratory for budworm egg masses.

COMMUNICATIONS

A ground radio communications system was set up to provide coordination among field crews and between the field crews and project headquarters. Two-way FM pack sets and personal portable units on Forest and Fire net frequencies were used. Good communications were obtained between most field locations and project headquarters except the northern and southernmost blocks. This communication system proved to be very valuable and an excellent timesaver especially just prior to and during the spray phase of the project. During this period it was necessary on many occasions to redirect the field crews during the course of the day.

The radios used are as follows:

1. Two, 2-channel VHF pack-sets at project headquarters.
2. Fourteen personal portable VHF units for field crews.
3. Four, 5-channel VHF pack sets for an overhead service net. One unit was left at project headquarters, four were mobile units.

NONTARGET MONITORING

Results of previous nontarget investigations have indicated there were adverse effects on several faunal groups subjected to aerial applications of Orthene. Investigators from Washington State University have reported severe losses of forest ants and domestic bees after applications of 1 and 2 lb/acre of Orthene in tests conducted in 1976 near LaGrande, Oregon. In these same studies researchers from the U.S. Fish and Wildlife Service determined that Orthene significantly reduced the brain cholinesterase (ChE) levels of several species of passerine birds. They concluded that the inhibition may be sufficient to threaten life.

Since the above studies were conducted at 1 and 2 lb/acre it was felt, at least with the three faunal groups discussed above, nontarget research involving a ½ lb/acre application should be conducted.

Researchers from the University of Idaho placed paired hives in 3 treated and 3 untreated blocks to determine the impact on domestic bees. In addition, 20 half-gallon milk cartons containing 25 soda straws were placed on trees and dead stumps to encourage nesting of wild bees, particularly *Osmia lignaria* Say. These were monitored before and after treatment in both treated and untreated blocks to determine effect on wild pollinators. The Pacific Southwest Forest and Range Experiment Station (PSW-2206), Davis, California, conducted a study on forest ants using several sampling techniques including drop cloths, pitfall traps, and marked ant mounds. An investigator from the University of California at Davis conducted bird cholinesterase studies by shooting and mist netting birds on treated and untreated blocks (pre and post treatment) and making brain cholinesterase determinations. Birds were also monitored using census techniques on treated and untreated blocks by University of Idaho personnel. The Pacific Southwest Forest and Range Experiment Station also monitored aquatic insect populations using drift and Surber samplers to determine if ½ lb/acre of Orthene adversely affected mayflies, stoneflies, or caddisflies. A final report discussing the results of the nontarget research will be issued in early 1978 by the Pacific Southwest Forest and Range Experiment Station, Davis, California.

LABORATORY PROCEDURES

The primary function of the field laboratory was to process the various field samples and tabulate the necessary data on the proper forms. Branch samples delivered to the laboratory each afternoon were placed in cold storage ($4^{\circ}C$). All samples were processed by the end of the day following their delivery.

One of the major tasks performed in the laboratory was the removal of budworm larvae from foliage samples. Traditionally, larvae were removed by hand. This year, however, a beating technique used successfully for several years by the Pacific Southwest Forest and Range Experiment Station was tried and provided excellent results with a significant time savings. The beating apparatus consisted of a metal garbage can mounted on a wood frame. The can was fitted with a removable wire mesh beating surface

and a pint jar was used to catch the budworm larvae (Figure 3). Larvae and debris dislodged during beating were brushed into the jar. Lab personnel would then separate, count, and record the larval data. This beating technique was used for the development, prespray, 3-day and 10-day samples.

LARVAL DEVELOPMENT SAMPLING

Following the collection of larvae from the foliage, laboratory personnel sorted them to instar on the basis of physical characteristics. These separations were systematically checked using head capsule measurements by the project entomologist. By the end of each day larval instar data were analyzed and used for decisions and planning for the following day (Appendix 6).

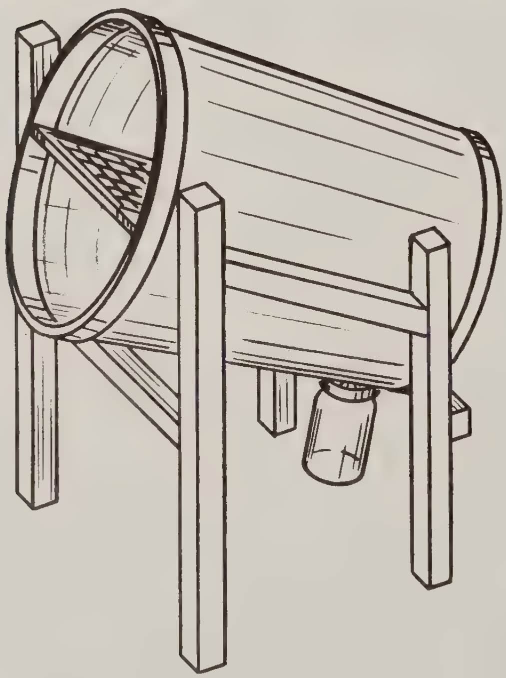

Figure 3. Beating barrel

PRESPRAY AND POSTSPRAY SAMPLING

Branch samples collected during prespray and postspray sampling periods were processed using the same beating method as used for the development samples. However, for these two samples larvae were not separated by instar. Only a total larval count by branch was recorded (Appendix 7, 8, and 9). The only separation made was between western spruce budworm and other larvae.

SPRAY DEPOSIT ASSESSMENT

Laboratory analysis of the spray deposit cards was conducted at the Los Alamos Scientific Laboratory under a contract with the Energy and Development Administration, Albuquerque, New Mexico. This analysis was made using an automatic scanning device that provided data on atomization (droplet spectrum), drop density, and volume of spray per unit area (Barry, et al., 1977).

DEFOLIATION ASSESSMENT

Before beating, 25 shoots from each branch of one of the three cluster trees were rated by defoliation class. Each new shoot was rated individually and the total rating for each branch was recorded (Appendix 10). Defoliation classes were defined as follows:

Percent Defoliation	Rating
0-25	1
26-50	2
51-75	3
76-100	4

Defoliation data was collected on the prespray and 10-day postspray branch samples.

EGG MASS SAMPLING

A temporary laboratory was set up in McCall,

Idaho, by the Boise Field Office, Forest Insect and Disease Management for their annual egg mass survey. In addition to samples collected from permanent plots located throughout the Forest, samples from the project clusters were also examined. Each branch was carefully inspected by egg mass checkers. All budworm egg masses (both old and new) were placed in individual containers by branch. Old and new egg masses were separated by a trained technician and tallied by branch (Appendix 11). Additional data were collected in the laboratory (see form) but will not be analyzed as part of this project.

Two methods were used to determine the area of each branch sample. The first was simply the length times width divided by two. A 100cm by 100cm grid was used in the second method. Each branch was clipped into small pieces and loosely arranged on the grid. The length and width of the area covered by the foliage were multiplied for the area (Grimble & Young, 1977).

SPRAY OPERATIONS

AIRCRAFT CONTRACTING

Specifications for type of helicopter and spray equipment were discussed with personnel of the Methods Application Group and the Pacific Southwest Forest and Range Experiment Station, Davis, California. Their information was very helpful in preparing the spray helicopter contract.

The project air officer working with the Region 4 contracting officer prepared a contract for one spray helicopter and one administrative chase helicopter. The award went to Evergreen Air of Montana, headquartered at Missoula for an Aerospatiale SA 315B Lama as the spray helicopter (subsequently substituted) and a Bell 206B Jet Ranger for administrative-chase use. Following is a resumé of Evergreen Air's bid for the 1977 Orthene Pilot Project.

Overall, no major problems were encountered in administration of the aerial spray contract.

Item	Quantity	Unit Price	Amount
1. Aerial application by helicopter of Government-furnished insecticide to National Forest, State of Idaho and Private Forest Lands.	4,000 A	$ 5.25	$21,000
2. Services of one light helicopter, fully operational with pilot, for observation (chase) of spray helicopters and administrative flights. A minimum of 20 flight hours will be guaranteed.	20 Hrs	235.00	4,700
		Total	$25,700

SPRAY EQUIPMENT

Aircraft: The spray helicopter was a Bell 206B Jet Ranger powered by an Allison C 20B turbojet engine.

Spray Equipment: Spray equipment consisted of a fiberglass, 150 gallon capacity, externally mounted belly tank with recirculating pump. Spray booms were standard Simplex air-foil type, 32 feet long.

Forty, 8004, flat-fan T-Jet nozzles were used. Nozzle bodies and diaphrams were standard. Fifty mesh screens were used.

The contractor also furnished a 10-wheel, 5,000-gallon stainless steel tanked, Kenworth nurse tanker. The configuration of this tanker allowed efficient mixing and bypass agitation.

Note: The spray helicopter was delivered with a closed system filler cap mounted on the main belly tank. In checking the aircraft filling procedures, it was found that the Kam-Lok filler cap on the aircraft could not withstand pressures delivered by the tanker's three-inch delivery hose. The belly tank filler cap had to be modified and an open-system delivery nozzle installed on the end of the filler hose. These modifications were satisfactory; however, it would have been more efficient to use a closed delivery system. Also, the possibility of accidental spills would be greatly reduced.

CALIBRATION

Calibration of the 206B spray helicopter was done at the McCall, Idaho, municipal airport. In the first attempt 34 of the 40 nozzles were observed to be leaking, plugged, or only delivering part of the inverted V flat-fan configuration. Inspection showed the entire spray system to be contaminated with a flaky, gray-white, brittle residue. After a 24-hour delay the system was cleaned and the calibration completed.

The forty 8004 flat-fan T-Jet nozzles at 40 psi boom pressure produced a 100-gallon delivery rate in six minutes. This in turn coincided with the predetermined figure of 16 acres per minute at 80 mph with an effective swath width of 100 feet.

CHARACTERIZATION

Prior to field characterization, it had been decided that a VMD (volume median diameter)[1/] of 200-220 μm(micrometer) would be desirable for the 1977 Orthene pilot project. This figure was extrapolated from prior experience with water-based sprays.

To characterize the 206B spray helicopter, four separate card lines were laid out on a taxiway at the McCall airport. The spray ship made passes over the centerline marker perpendicular to the card lines. The airspeed was 80 mph and altitude approximately 50 feet.

After each of the four separate spray passes were made, cards were allowed to dry and then "read" to establish VMD's. Field measured VMD's were 225, 216, 207, and 190 μ. These figures were considered adequate and no further adjustments were made to the spray aircraft.

METEOROLOGICAL CONDITIONS

Meteorological services were furnished by the W.S.F.O. National Weather Service, Office of the National Oceanic and Atmospheric Administration (N.O.A.A.) at Boise, Idaho.

1/ Volume median diameter is the drop diameter satisfying the requirement that half of the volume of liquid is in drops smaller and half is in drops larger than the VMD.

A mobile fire weather unit and operator arrived at the McCall project headquarters on June 23, 1977, and terminated operations on June 29, 1977. The operator provided daily weather observation data and extended forecasts. Spot forecasts were also provided the day prior to anticipated spray operations.

Overall, weather conditions during the four spray days were ideal. Criteria for terminating treating was a free air temperature 65°F (19°C) and wind speed exceeding 6 mph. The highest temperature recorded during spraying was 54°F (12°C); highest wind speed attained was 4 mph.

In addition to weather information from the mobile unit at McCall, provision was made for ground personnel to take temperatures, relative humidities, and wind speed/direction within each spray block on actual spray days. This information was gathered starting at 5:00 a.m. and taken at 15 minute intervals until spraying was completed. The information was relayed by portable radio to the observation aircraft overhead. This gave the observer information with which he could prevent spraying past temperature and wind speed limits within each spray block.

COMMUNICATIONS

Communications for the aerial operations portion of the project consisted of the following nets:

1. One, 360-channel, battery operated VHF base station set for ground-to-aircraft communication. This unit was located at the base heliport during spray operations.
2. Communication between the spray and observation aircraft was by 360-channel transceivers.

A request was made to the FAA for two discreet frequencies for air-to-air and air-to-ground communications during spray operations. These were assigned by the FAA, Airways Communications Center, Seattle, Washington.

Overall, the communication nets worked satisfactorily.

SAFETY PROCEDURES

The goals of the project safety plan were: (1) no fatalities, (2) no lost time accidents, (3) no vehicle accidents, and (4) a minimum number of minor accidents. These goals were basically met by following the safety procedures outlined in the plan. One minor accident did occur that resulted in time lost when a field crew member strained a back muscle while forcing her way through a brush field.

Preventive measures that were carried out for the project included the following:

GROUND PHASE

1. Training sessions were held covering first aid and driver's training. Forest Service and State of Idaho driving manuals were made available to all field crewman for study. Testing was conducted prerequisite to issuing Forest Service drivers' licenses for use of government vehicles.
2. Safety equipment, mainly hard hats, were issued to all field crewmen.
3. Notification of the project was given to the county sheriffs for Valley and Adams Counties, the McCall city police and the Idaho State Police. We also notified the Valley County Hospital and a local physician and provided them with information relevant to Orthene.

4. The pesticide was stored in a locked room of a large Forest Service storage shed. The door was posted with a sign reading "Pesticide Storage." Only the amount needed for each day's spray was removed at any one time.
5. Those involved with mixing of the pesticide wore protective coveralls, gloves, and a respirator. These were changed each day and discarded with the empty insecticide containers.
6. At the heliport sites the landing area was flagged to keep nonessential personnel and vehicles out of the critical area. When necessary, the helipads were watered down to eliminate dust. No smoking signs were posted near the fuel trucks to help avoid the potential for fire. U.S. Forest Service heliport kits were always in place for communications and other needs, especially to be available in case of an emergency.
7. In certain high vehicle use areas the roads were blocked off to prevent traffic during the actual spraying.
8. A list of emergency phone numbers was posted for use in case of an accident or pesticide spillage.

HELICOPTER OPERATION PHASE

The helicopter operations safety plan is very comprehensive and covers all stages of the project. The main objectives of the action plan are summarized below:

1. To protect the general public by restricting travel into or through the spray block during the actual spraying.
2. To assure safety of personnel working at or visiting the heliports with special precautions to be followed while the helicopters were on the ground.
3. To assure safe operation of the helicopter through preflight inspections, and other general safety precautions. The contracting officer's representative had authority to suspend operations if unsafe conditions were found.
4. To assure pilot safety by following prescribed safety flying procedures.
5. To provide for competent first aid and emergency action in case of an accident or helicopter crash.
6. To provide for prompt assistance in case of an emergency by having a list of phone numbers for local specialists including the ambulance, hospital, and a designated physician.

INFORM AND INVOLVE

Public involvement and information for this pilot control project began in November 1976 with the appointment of a western spruce budworm information committee. The group was comprised of representatives from the Forest Service, Boise Cascade Corporation, and the Idaho Department of Lands. While their charter was to provide general information and determine local reaction to the budworm, they included information relative to the project.

The committee prepared news releases, held public information meetings, and sent a letter (Appendix 12) to over 600 private landholders in the area describing the situation and asking for comments. Through efforts of the Boise Field Office, Forest Insect and Disease Management, colored slides and background information about the budworm was made available to Boise television stations.

After project personnel were established in McCall, involve and inform efforts directly related to the project increased substantially.

Interviews were held with the local radio station and newspaper. Presentations about the project were also given to the Rotary Club and a Ranger's meeting for the Payette National Forest.

Shortly after the spraying started, I & I personnel from the Boise National Forest arranged for a "news media day" inviting representatives from radio, television, and newspapers to visit the project. City and county officials from the local area were also invited for that day. Approximately 15 people were there representing three counties, the city of McCall, three newspapers, one radio station, and one television station. The program included a presentation on the western spruce budworm, the pilot control project and the field testing being conducted in the area, a tour of the laboratory, and a helicopter ride, provided by Boise Cascade Corporation, to view the spray operation.

Several other agencies were informed of the project and invited to visit during the spray operations phase. These included the Idaho Department of Fish and Game, Boise and McCall offices; the Environmental Protection Agency, Seattle and Boise offices; and Forest Service, Forest Insect and Disease Management personnel from several areas outside of Region 4. A description of the project with a brief review of tentative results was also presented during a joint field trip of the Intermountain Forest Pest Action Council and the Society of American Foresters.

A special coordination meeting was held with representatives of the local Ranger Districts on whose land the testing was being conducted. The purpose was to avoid confusion by informing them of the flagging system being used for the various projects. The need for improved coordination became evident when a tree planting crew became confused on the location of the planting site due to flagging which marked a monitoring plot.

PROJECT ORGANIZATION

Personnel from the Forest Insect and Disease Management Staff, State and Private Forestry, Region 4; Idaho Department of Lands; and the Payette National Forest administered the project. Overall coordination and supervision of the project was the responsibility of the Director of Forest Insect and Disease Management, Region 4, Forest Service.

The State of Idaho, Department of Lands, provided the project director and a 10-person field crew. The Payette National Forest was responsible for administrative services, a heliport manager, and a 10-person laboratory crew. The project entomologist and laboratory assistant came from the Ogden Field Office, Forest Insect and Disease Management, and the air operations officer came from the Boise Field Office, Forest Insect and Disease Management. The complete project organization is diagrammed in Figure 4.

BUDGET SUMMARY

This project was financed by the Washington Office, Forest Insect and Disease Management, and was administered by Forest Insect and Disease Management, State and Private Forestry, Region 4. Table 2 shows the actual expenditures by budget item for the project. Also included are the amounts for contributed salaries, vehicle use, and miscellaneous supplies. The State of Idaho received $17,600 for the field crew (10 people), travel and per diem for the project director, and for State overhead. The actual cost of the project fell well within the financed budget of $100,000. The balance was used to partially finance a reinvasion study and an egg mass survey, both within the project blocks.

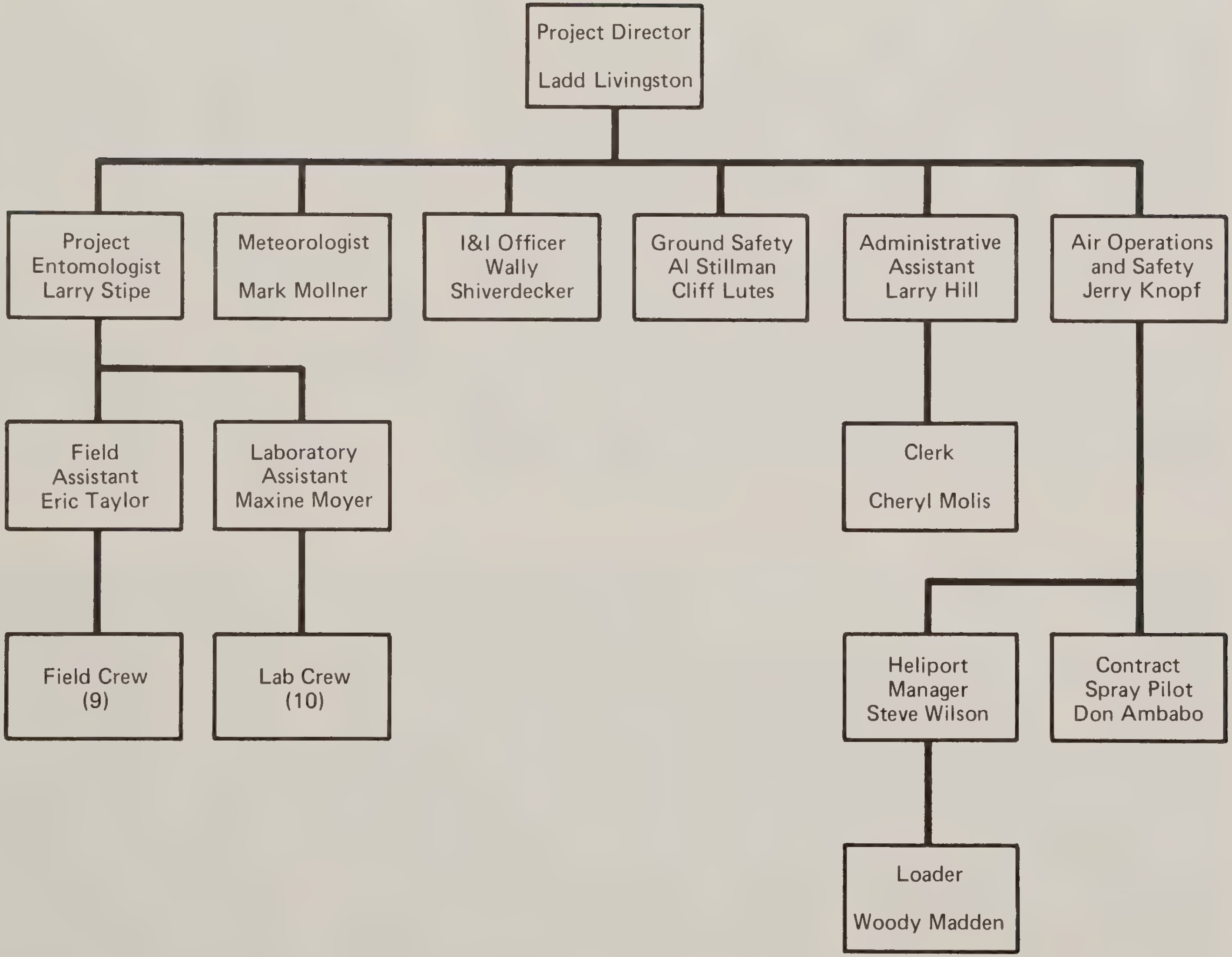

Figure 4. Orthene pilot project organization chart.

Table 2. Project Budget

	Regular	Project Budget	Overtime	Contributed
Aircraft				
Spray helicopter		$21,000.00		
Observation helicopter		5,000.00		
Pesticide				
Orthene forest spray		7,700.00		4,300.00
Rhodamine dye		380.00		
Vehicle rental and supplies				
Vehicles		4,605.00		624.00[1]
Gasoline and oil		1,325.00		
Services		545.00		
Equipment (field and lab)		11,550.00		
Personnel Salaries	Regular		Overtime	
Forest Service				
Administrative Officer	--		--	250.00
Project Entomologist	--		910.00	8,200.00
Air Operations Officer	--		270.00	3,600.00
Lab Assistant	--		440.00	1,630.00
Clerk	--		295.00	380.00
Lab Crew (10)	4,550.00		1,590.00	--
Heliport Manager	105.00		245.00	--
Safety Officer	160.00		--	--
State of Idaho				
Project Director	--		--	3,340.00
Field Crew (10)	10,540.00		2,522.00	--
Lab Technician	--		--	435.00
Sub total (salaries)		21,627.00		
Travel and per diem				
Planning phase		1,250.00		
Field Phase		7,655.00		
Services				
Spray deposit card analysis		1,300.00		
Meteorologist		470.00		
Telephone		385.00		
Lab rental		445.00		
Maps and aerial photographs		150.00		
Regional Office overhead		5,490.00		
State of Idaho overhead		2,490.00		
TOTAL		93,367.00		22,759.00

[1] Includes $174.00 from State of Idaho.

RESULTS

LARVAL DEVELOPMENT SAMPLING

Blocks were released for treatment when larval development in each block reached 50 percent 5th and 6th instar. Blocks were released as follows:

BLOCK NO.	RELEASE DATE	PERCENT 5th AND 6th INSTAR
1	June 20	50
2	June 25	70
3	June 24	54
4	June 23	51
5	June 22	49
6	June 23	53
7	June 24	58
8	June 24	56

The above release dates determined the sampling and treatment sequence for the rest of the project. Table 3 outlines all prespray, postspray, and treatment activity.

POPULATION REDUCTION

An average population reduction of 91.0 percent was achieved by applying Orthene Forest spray to four treated blocks. The 10-day residual budworm larvae per 100 buds was 2.9 in the treated blocks compared to 17.6 in the check blocks (Table 4). The prespray population levels between blocks were not significantly different (Figure 5 and Table 5) but became so at the 3- and 10-day postspray periods (Figure 5, Tables 6 and 7).

The 91.0 percent population reduction represents unadjusted mortalities. Adjusted population reduction using covariance adjusted means was 87.6 percent and 86.1 percent using Abbott's adjustment (Table 8).

DEFOLIATION ASSESSMENT

The defoliation index estimates determined prior to spraying were 54.5 percent for the treated blocks and 46.6 percent for the untreated blocks. The 10-day postspray defoliation index was 57.1 and 59.0 for the treated and untreated blocks respectively (Table 9).

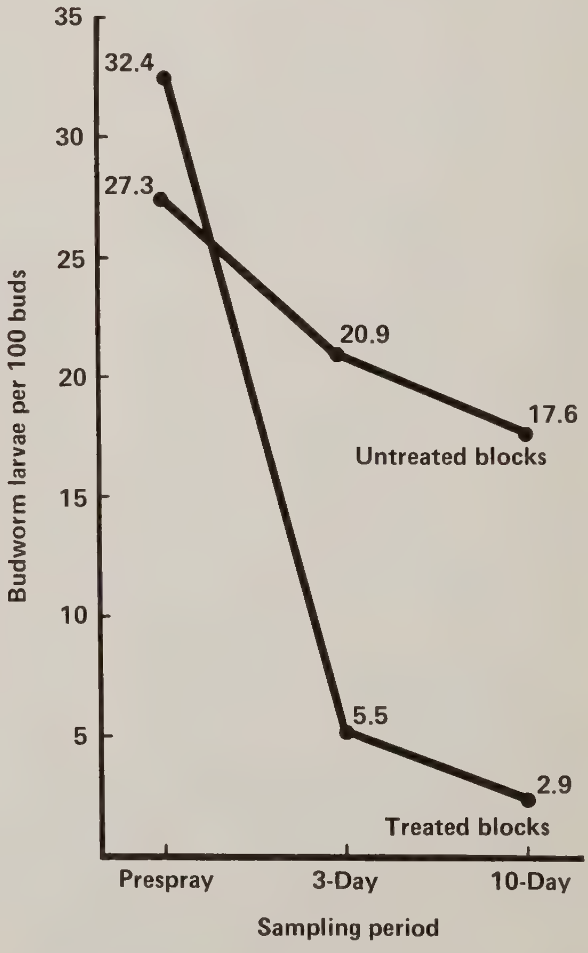

Figure 5. Budworm population by sampling period for treated and untreated blocks.

Table 3. Sampling and treatment sequence.

		Treated Blocks			Untreated Blocks			
Date	Block #1	Block #2	Block #3	Block #4	Block #5	Block #6	Block #7	Block #8
June 20	Released[1]							
21	Delay							
22	Prespray				Released			
23	Treated			Released		Released		
24			Released	Prespray		Prespray	Released	Released
25		Released	Prespray	Treated	Prespray	Treated[2]		
26	3-Day		Treated		Treated[2]		Prespray	
27		Prespray					Treated[2]	Prespray
28		Delay		3-Day		3-Day		Treated[2]
29		Treated	3-Day		3-Day			
30							3-Day	
July 1								3-Day
2		3-Day						
3	10-Day							
4								
5				10-Day		10-Day		
6			10-Day		10-Day			
7							10-Day	
8								10-Day
9		10-Day						
10								

1/ Blocks were released for treatment when 50 percent of the larvae were in the 5th and 6th instar.

2/ No insecticide was applied in untreated (check) blocks.

Table 4. Spruce budworm larval populations and unadjusted mortalities by treated and untreated blocks.

Block	Budworm Per 100 Buds						Unadjusted Mortality			
	Prespray		Postspray							
			3-Day		10-Day		3-Day		10-Day	
	Mean	S.E.[1]	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.
Treated							percent			
1	37.2	3.1	8.0	1.1	2.5	0.6	78.5	--	93.3	--
2	20.0	2.4	3.3	0.5	3.2	0.7	83.3	--	84.2	--
3	43.1	4.0	5.4	0.7	4.1	0.8	87.4	--	90.5	--
4	29.2	3.0	5.3	0.8	1.8	0.5	81.9	--	93.8	--
Average	32.4	5.0	5.5	1.0	2.9	0.5	83.0	1.8	91.0	2.2
Untreated										
5	33.6	3.7	23.8	2.6	24.7	3.0	29.2	--	26.6	--
6	35.9	3.0	28.3	2.9	19.1	2.0	21.2	--	46.7	--
7	20.2	2.2	13.6	1.7	12.6	1.4	32.5	--	37.6	--
8	19.5	2.5	17.8	2.6	13.8	2.6	8.2	--	29.2	--
Average	27.3	4.3	20.9	3.2	17.6	2.8	23.4	5.3	35.5	4.5

[1] The standard errors shown for each block are within the block sampling error based on 25 clusters. The standard errors for the averages are based on the 4-block average.

Table 5. Analysis of variance table comparing the treated blocks and overall within-block sampling error, prespray.

Analysis of Variance					
Source	d.f.	S.S.	m.s.	F.	F_{95}
Treatments	1	1,286.7	1,286.7	.589	5.99
Experimental Error	6	13,107.6	2,184.6	9.482	2.14
Sampling Error	191	44,002.5	230.4	--	--
Total	198	58,396.8	--	--	--

H_o: Prespray population levels (budworm per 100 buds) for the treated and untreated blocks are equal.

Conclusions: The treated and the untreated blocks are not significantly different and we may conclude that they come from the same population.

Table 6. Analysis of variance table comparing the treated and untreated blocks and overall within-block sampling error, 3-day postspray.

Analysis of Variance					
Source	d.f.	S.S.	m.s.	F.	F_{95}
Treatments	1	11,515.5	11,515.5	20.722	5.99
Experimental Error	6	3,334.3	555.7	6.631	2.14
Sampling Error	191	16,012.3	83.8	--	--
Total	198	30,862.1	--	--	--

H_o: Three-day postspray population levels (budworm per 100 buds) for the treated and untreated blocks are equal.

Conclusions: The treated and the untreated blocks are significantly different. This difference is obvious when looking at the plots of means (Figure 14).

Table 7. Analysis of variance table comparing the treated and untreated blocks and overall within-block sampling error, 10-day postspray.

Source	d.f.	S.S.	m.s.	F.	F_{95}
Treatments	1	10,694.6	10,694.6	27.164	5.99
Experimental Error	6	2,362.2	393.7	5.445	2.14
Sampling Error	191	13,817.0	72.3	--	--
Total	198	26,873.8	--	--	--

H_O: 10-day spray population levels (budworm per 100 buds) for the treated and untreated blocks are equal.

Conclusions: The treated and untreated blocks are significantly different. This difference is obvious when looking at the plots of means (Figure 1).

Table 8. Mortalities for the combined treated blocks by method.

Method	3-Day Postspray	10-Day Postspray
	percent	percent
Unadjusted[1/]	83.0	91.0
Adjusted by Covariance[2/]	78.9	87.9
Adjusted by Abbott's Formula[3/]	77.8	86.1

[1/] Unadjusted mortality $= (1 - \frac{\text{Postspray}}{\text{Prespray}}) \cdot 100$

[2/] Adjusted mortality by covariance $= (1 - \frac{\text{Adj. Postspray Treated}}{\text{Adj. Postspray Untreated}}) \cdot 100$

[3/] Abbott's Adjustment $= (1 - (\frac{\text{Post (Treated)}}{\text{Pre (Treated)}}) \cdot (\frac{\text{Pre (Untreated)}}{\text{Post (Untreated)}})) \cdot 100$

Table 9. Defoliation estimates for the treated and untreated blocks, prespray and 10-day postspray periods.

Block	Prespray		10-day Postspray		Percent Change[2]
	Mean	S.E.[1]	Mean	S.E.[1]	
Treated					
1	50.7	4.8	52.0	4.0	2.6
2	43.0	3.9	49.6	5.1	15.4
3	72.1	5.1	74.3	5.7	3.1
4	52.2	4.4	52.5	5.0	0.6
Average	54.5	6.2	57.1	5.8	4.8
Untreated					
5	52.5	5.6	66.1	5.5	25.9
6	57.1	4.9	68.3	4.9	19.6
7	44.8	4.1	50.1	3.9	11.8
8	31.9	2.0	51.6	5.1	61.8
Average	46.6	5.5	59.0	4.8	26.6

1/ The standard errors shown for each block are the within-block sampling errors based on 25 clusters. The standard errors for the averages are based on the four block averages.

2/ The percent change is calculated as follows:

$$\text{Percent Change} = \left(\frac{\text{Post - Pre}}{\text{Pre}}\right) . (100).$$

The change in the defoliation index from the prespray to the postspray can be interpreted by the amount of additional foliage lost after spraying. The percent change in the treated blocks averaged 4.8 compared to a 26.6 change in the untreated blocks. Hence, the foliage saved by spraying can be interpreted as the difference, or 21.8 percent.

SPRAY DEPOSIT ASSESSMENT

The Kromekote cards were assessed for deposit by the Quantimet image analyzer at Los Alamos Scientific Laboratory, Los Alamos, New Mexico. The Quantimet sized and counted spray droplet stains on the card and the results were processed through the ASCAS computer program (Young, et al., 1977) by the Forest Service, Forest Insect and Disease Management, Methods Application Group, Davis, California.

Measurements used to evaluate spray deposition were:

1. Droplet density expressed in drops per cm^2.
2. Drop size:
   Volume median diameter (μm).
   Number mean drop diameter (μm).
3. Spray volume recovery (gallons per acre).

Results are provided in Table 10. Droplet density measured beneath the trees ranged from 2.2 to 5.8 drops per cm^2 and as expected higher in the adjacent open areas where it ranged from 4.6 to 11.3 drops per cm^2. The volume median diameter (VMD) and the number mean drop (NMD) diameter were in the expected size range of 263 to 325 μm for VMD and 128 to 177 μm for NMD. The volume of spray recovered beneath sample trees ranged from 0.09 to 0.18 GPA or 9 to 18 percent of the application rate. Spray recovered in the open, as expected, was higher ranging from 0.24 to 0.41 GPA or 24 to 41 percent of the application rate.

Table 10. Summary Spray Deposit Data, Pilot Project, R-4, 1977.

Block		Drops/cm^2	VMD (um)	Number Mean Drop Dia. (um)	Volume Recover gallons/acre	Block[1/] Mortality
1	Trees	4.5	273	128	.14	93.3
	Open	7.8	290	147	.33	
2	Trees	2.2	306	136	.09	84.2
	Open	11.3	260	144	.41	
3	Trees	3.4	281	139	.12	90.5
	Open	4.6	325	177	.32	
4	Trees	5.8	267	131	.18	93.8
	Open	7.0	263	136	.24	

[1/] Unadjusted mortality.

EGG MASS SAMPLING

There was no significant difference in egg mass estimates between the treated (5.1) and untreated (6.2) blocks (Table 11). While this conclusion is inconsistent with the 10-day residual populations, it was not unanticipated. A reinvasion study of two of the spray blocks using pheromone sticky traps found that within 6-9 days of initiation of flight, male budworm moths were being trapped just as intensely at the center of the plots as outside the perimeter (Markin, personal communication).

SPRAY COST PER ACRE

Based only on the cost for application (spray and observation aircraft), insecticide, and dye the treatment cost per acre was $9.60. This figure was calculated assuming all of the insecticide was purchased at $3.40 per pound.

Table 11. Egg mass estimates for the treated and untreated blocks.

Block	Egg Masses Per Square Meter				Egg Masses Per Branch		Defoliation Class Predicted for 1978
	Length X Width Method		Grid Area Method				
	Mean	S.E.[1]	Mean	S.E.	Mean	S.E.	
Treated							
1	1.9	.4	1.5	.3	.4	.1	Moderate
2	2.6	.5	1.7	.3	.6	.1	Moderate
3	9.5	1.7	7.1	1.2	1.9	.2	Heavy
4	6.4	1.0	5.0	.8	1.3	.3	Heavy
Average	5.1	1.8	3.8	1.4	1.1	.3	Heavy
Untreated							
5	2.6	.5	2.3	.4	.5	.1	Moderate
6	7.1	1.4	4.8	.7	1.7	.3	Heavy
7	4.7	1.4	3.4	.8	.9	.3	Moderate
8	10.4	1.6	8.0	1.3	2.2	.4	Heavy
Average	6.2	1.7	4.6	1.2	1.3	.4	Heavy

1/ The standard errors shown for each block are the within-block sampling errors based on 25 clusters. The standard errors for the averages are based on the four block averages.

DISCUSSION

EFFICACY

Objective No. 1 of this pilot control project is to compare the results of applying Orthene at ½ lb AI/acre with the results of past Orthene field tests. Table 12 shows these results.

Compared to the field tests of 1975 and 1976 (Dolph, 1976, Markin, et al., Markin) our test produced slightly lower mortality rates. This slight difference may be due only to the higher application standards that can be maintained in a smaller scale field test.

The population reduction of 91 percent unadjusted mortality obtained in this test compares very favorably with the 93.8 percent obtained by applying Orthene at 1 lb/acre in the 1976 pilot control project in Montana (Flavell, et al., 1976). The differences in mortality rates for all of the tests, both small-scale field tests and the pilot control projects, do not appear to be significantly different from each other. It appears that Orthene applied at ½ lb AI/acre can be as effective as when applied at 1 lb AI/acre.

MORTALITY

The overall population reduction of 91 percent and the residual population of 2.9 larvae per 100 buds were within the project objective No. 4. Although this project objective

Table 12. Results of Orthene field and pilot control tests against the western spruce budworm, 1975-1977.

Date	Area of Test	Dosage	Results (Insect Mortality)	Reference
1975	Washington	1 lb AI in 1 gallon water/acre, applied at 50% budbreak	53.4% (corrected)	Dolph 1977
		1 lb AI in 1 gallon water/acre, applied with 50% of larvae in 5th instar	99.3% (corrected)	
1975	Washington	1 lb AI in 2 gallon water/acre, large and small drops	large drops (251 VMD) 83.8% small drops (200 VMD) 90.8%	Markin (et al.)
1976	Montana	½ lb AI/100 gallon applied to run-off	100% (a ground treatment)	Kohler 1977
1976	Montana	½ lb AI/acre	93.8% unadjusted (86.8% adjusted by covariance)	Flavell (et al.) 1976
1976	Idaho	1 lb AI/acre ½ lb AI/acre ¼ lb AI/acre	98% 93% 77.5%	Markin
1977	Idaho	½ lb AI/acre	91% unadjusted (87.6% adjusted by covariance)	This report

was met, block 2 with 84 percent mortality was well below the others which were all above 90 percent. Block 2 was released for treatment with the highest proportion of larvae in the 5th and 6th instar (70 percent). The next highest was block 3 with 54 percent. On the designated spray day for block 2 a minor mechanical problem with the spray helicopter caused the treatment to be delayed one day. As a result, at treatment time larval development in block 2 was well beyond 70 percent 5th and 6th instar. Further evidence of the advanced stage of larval development was the large increase in defoliation from prespray to 10-day postspray in block 2. The increase of 15 percent in block 2 was over 3 times that recorded in the next highest treatment block (No. 3). Also, block 2 had the highest spray deposit recovery rate in amount per acre on the open cards. The full effect of these factors is not known but they probably played a part in causing the low mortality in block 2. Although not statistically sound, the response shown in block 2 indicates that late treatment may cause reduced mortality.

The residual population of 2.9 in the treated blocks was statistically different than 17.6 in the untreated blocks. However, there was little difference in the number of egg masses per square meter (5.1 treated vs. 6.2 untreated). This loss in identity between treated and untreated populations from the 10-day postspray period to the egg mass sample (approximately 60 days) resulted from inflights of adult moths from outside the treated blocks. Heavy defoliation is predicted for both treated and untreated blocks in 1978. At the population level found in the treated blocks (prespray-32.4 larvae per 100 buds), 1,000-acre blocks are not large enough to prevent reinvasion to a level prior to treatment.

SPRAY DEPOSIT

The purpose of the spray deposit sampling was to obtain a measure of the overall quality of application and quantity of deposit at and near the sample tree clusters. Based upon the deposit data (0.09-0.18 GPA under the trees and 0.24-0.41 GPA in openings) the quality of the application was good and the deposit density acceptable.

Block 2 results had the lowest droplet density beneath the sample trees and the highest recovery in the open areas. This suggests that relative to the other blocks, application was more erratic in this block. The low insect mortality in block 2 (which was the lowest of all treated blocks) also supports this observation.

OPERATIONAL PROBLEMS

The most important problem did not come to our attention until after the field portion of the project had terminated. Analysis of the spray taken from the mixing tanks showed that the formulation was consistently higher than the ½ lb AI/gallon desired (Table 1). At least part of the reason was found to be that the original pesticide was manufactured at a rate of 80.25 percent AI rather than at the 75 percent advertised rate. This brings up the question—can our mortality rates be taken to represent an application rate of ½ lb/acre? Since the 80.25 percent rate would only make a potential increase of .035 lb AI/acre sprayed (for each spray tank 670 lb of pesticide were used; (670 x .8025) - (670 x .75) ÷ 1,000 acres = .035) it is doubtful there would be a statistically reliable difference in the mortality for the two rates.

Several operational problems were encountered and resolved during the course of the project. These included: pilots that were not

properly carded (resolved through special training arranged for by the contractor and through negotiations by the regional air officer); several items that did not meet contract specifications (taken care of by the contractor); a dirty spray system (cleaned by the contractor with a 24-hour delay); a spray pump on the helicopter that failed (changed by the contractor between 12 noon and 5:00 a.m.); a broken observation port on the rotor of the spray helicopter (changed by the contractor with a 24-hour delay); and a gasoline truck with a flat tire and no spare (taken care of by the contractor).

Another problem was that during the busiest time of the actual spray application, the field crews, who were being used for development sampling, population sampling, and spray deposit card placement and retrieval, became physically and emotionally exhausted and were reduced in their functional capabilities. This problem was relieved by using a timber inventory crew working in the area to put out the deposit cards, thus giving the regular crews a chance to rest.

COST PER ACRE

Objective No. 3 for this project was to determine the unit cost for the operational use of Orthene. Calculated on the basis of application, insecticide, and dye, Orthene was applied at $9.60 per acre. For an operational control program over large areas the unit cost per acre would be less. For larger projects the insecticide cost should not change, but the use of larger spray aircraft could lower the unit cost of application. Depending on the size of the project and the amount of sampling required and excluding planning, an operational project would be expected to cost between $7 and $10 per acre.

RECOMMENDATIONS

REGISTRATION OF ORTHENE

With the mortality of 91 percent obtained in this project, from the standpoint of efficacy, or the ability of the chemical to reduce the population, we recommend that Orthene be registered at ½ lb AI/acre for use as a forest spray to control the western spruce budworm.

FIELD OPERATIONS

For the most part, field sampling procedures provided an efficient means of collecting the required samples and data within the manpower and time constraints of the project. Several items of particular value in improving field procedures follow:

1. **Manpower flexibility.** To provide a larger work force in the field during the spray phase of the project, two types of field crew appointments were used. Six temporary employees made up the nucleus of the field crew and were trained in all aspects of field work on the project. Four additional employees were hired on an as-needed basis. When the work load increased beyond what the three 2-person crews could handle, these additional crew members were paired up with one of the fully trained crewmen. This technique provided five 2-person crews, with the option of using other project members (lab crew) to provide six 2-person crews. Nonproductive time during the early stage of the project was avoided and, when needed, fully trained crews were available.

2. **Assistant Project Entomologist.** On either pilot or operational projects, it is strongly recommended that an assistant project entomologist position be established. This individual would function in a liaison capacity between the project entomologist and field crew supervisors.

3. **Colored field forms.** Previously described were four sampling periods (development, prespray, 3-day postspray, and 10-day postspray) which, due to differences in development, overlapped one another. This made it necessary to collect and process more than one sample at the same time. By printing the field forms for each sampling period on a different colored paper, all problems concerning which type of sample was needed or being processed in the laboratory were eliminated.

4. **Radio communications.** Two-way radio communications between field and laboratory is an effective timesaver for both supervisory and field personnel. Historically, however, on pilot or operational spray projects, communications often become a problem either through lack of radios or having to settle for older equipment that does not function properly. Partial relief from the radio acquisition problem has come by borrowing fire cache radios from within or outside the Region. At best, this is not a solution because the radios could be withdrawn in event of a large fire.

The best solution would be to purchase a complete radio system with project money. Other Regions should do the same and in one or two years a Forest Insect and Disease Management radio cache could be established. This would provide flexibility where Regions could borrow these project nets whenever they conducted pilot and/or operational spray projects.

A Basic VHF communications system with tactical and service nets plus air net capabilities and one repeator would cost approximately $25,000.

5. **Branch sample bundles.** To avoid confusion and provide better inventory control over the large number[1] of branch samples collected and transported to the laboratory each day, branch samples from each cluster were maintained as a unit by stapling the bags together at the time of collection. This technique was especially helpful when transferring samples between the field, cold storage, and the laboratory.

Improvements or changes would have been helpful in the following areas:

1. **Road markings.** Better road markers would have prevented many problems relative to plot and cluster locations, and access to these areas in the predawn for spray deposit card placement. Written tags placed at critical road junctions would provide positive identification as to location. Although cluster locations were marked along roads with plastic flagging, this technique was found inadequate in many cases and particularly at night. Near the end of the project, wooden stakes were placed at the edge of the roads to identify cluster locations. These stakes were easily seen during the day and via vehicle headlights at night.

2. **Cluster identification numbers.** In the haste of collecting branch samples within the time allowed, many cluster identification numbers required on the field forms were not recorded. This caused confusion among the lab crew and potentially could have caused errors in the data. Bundling branch samples by cluster enabled lab personnel to correct any errors, but this problem did cause extra work. It is suggested that field forms be completed as much as possible in the vehicle before collecting begins.

LABORATORY OPERATIONS

Laboratory efficiency and the day to day

1/ Over 7500 branches were examined during the project.

routine could be improved by the following:

1. **Lab space.** Provide separate space for the field and lab personnel. On many occasions confusion and distraction was experienced because the work area in the lab used by the field crews was also shared by the lab crew. Visitors and other project personnel also contributed to this problem. It is suggested that separate rooms be provided for the field and laboratory phases of a project.

2. **Branch examination.** Branch samples bundled by cluster were separated in the lab and examined on a first come first serve basis. This procedure caused data from each cluster to become somewhat disorganized. It would be a more efficient and organized process if one person selected a complete bundle of cluster branches and completed it before moving on to another bundle.

3. **Equipment.** During the early phase of the project when budworm larvae were small, individual magnifying ring lights were needed. For our project, three ring lights and three desk lamps were shared by ten people. This caused problems which could be avoided by having adequate equipment.

Procedures which resulted in increased efficiency were the following:

1. **Branch beating.** Although no direct comparison was made between the beating technique and the conventional method of removing larvae by hand, it was readily apparent that the beating procedure was more efficient and less prone to error.

2. **Separating larval instars.** Only two lab persons were trained to separate budworm larvae by instar. This reduced the amount of time needed for training and also reduced the inherent amount of variation involved if more people were trained for this task. As it turned out, two people separating larvae were able to keep pace with eight beating and searching for larvae.

3. **Recording data.** The same two people trained for separating larval instars were also trained to correctly record the necessary data on the many lab forms. They were also able to organize and maintain good control over the continuous flow of data being handled by the lab.

AIRCRAFT CONTRACTS

1. **Tank filler system.** Contracts for spray aircraft (helicopters and fixed-wing) should specify use of a Buckeye, or equivalent, "dry-break" filler system. These units provide for rapid loading of spray aircraft using a closed system. They are convenient and provide maximum safety for insecticide loaders.

2. **Early inspection of aircraft.** Provision in spray contracts should be made for early inspection of spray aircraft. This should be done 7-10 days prior to anticipated start of operations. The contracting officer's representative for the spray project should do an actual prespray calibration at which time the system could be thoroughly checked for leaks, contamination, proper pressures, etc.

3. **Early pilot carding.** Contracts should provide for pilot proficiency and carding to be done at least 7 days prior to the anticipated start of spraying.

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APPENDIX

APPENDIX 1 Cluster Location Field Form

BUDWORM CLUSTER PLOT LOCATION

Name____________________ Block No.__________ Cluster No.__________

Cluster Established: Day__________ Month______________ Year__________

Aspect: N S E W Slope: Steep Moderate Gentle

Tree	Species (DF/GF)	Height (ft)	Prior Defoliation (%)
1			
2			
3 .			

Directions to Cluster (with map)

APPENDIX 2 Development Sample Field Form

DEVELOPMENT SAMPLE (45cm Branch)

Collectors____________________________ Block No.__________

Day__________ Month__________ Year__________ Plot No.__________

Tree No.__________ Length__________ cm Width__________ cm

Branch: 1N 2E 3S 4W

REMARKS:

APPENDIX 3 Prespray Population Sample Field Form

BUDWORM POPULATION SAMPLE (45cm Branch)

Collectors____________________________________Block No.____________

Day____________Month____________Year____________Cluster No.____________

Tree No.____________________Length____________cm Width____________cm

Branch: 1N 2E 3S 4W

REMARKS:

APPENDIX 4 Three-day Postspray Field Form

BUDWORM POPULATION SAMPLE (45cm Branch)

Collectors ______________________________ Block No ____________

Day ____________ Month ____________ Year ____________ Cluster No. ____________

Tree No. ____________________ Length ____________ cm Width ____________ cm

Branch: 1N 2E 3S 4W

REMARKS:

APPENDIX 5 Ten-day Postspray Field Form

BUDWORM POPULATION SAMPLE (45cm Branch)

Collectors ______________________________ Block No. __________

Day __________ Month __________ Year __________ Cluster No. __________

Tree No. ______________ Length __________ cm Width __________ cm

Branch: 1N 2E 3S 4W

REMARKS:

BUDWORM DEVELOPMENT DATA

Year________ Region________ Forest________ Host________

Block No.________ Plot No.________ Branch: Length______cm Width______cm

		BUDWORM STAGE						BUD DEVELOPMENT		
Tree	Branch	3rd	4th	5th	6th	Pupae	Total	Closed	Open	Total
1	1									
	2									
2	3									
	4									
TOTAL										
PERCENT										

APPENDIX 7 Prespray Population Laboratory Form

Block Name________________

Spray________Check________

BUDWORM POPULATION DATA

Year________Region________Forest________Host________

Block No.________Cluster No.________Sampling Period________

Day______Month______Branch: Length______cm Width______cm

Tree	Branch	Larvae	Pupae	Cases	Total	No. Buds	Larvae per 100	Other Larvae	Other Pupae
15	16 1	17 - 19	20 - 22	23 - 25	26 - 28	29 - 31			
	32 2	33 - 35	36 - 38	39 - 41	42 - 44	45 - 47			
1	48 3	49 - 51	52 - 54	55 - 57	58 - 60	61 - 63			
	64 4	65 - 67	68 - 70	71 - 73	74 - 76	77 - 79			
15	16 1	17 - 19	20 - 22	23 - 25	26 - 28	29 - 31			
	32 2	33 - 35	36 - 38	39 - 41	42 - 44	45 - 47			
2	48 3	49 - 51	52 - 54	55 - 57	58 - 60	61 - 63			
	64 4	65 - 67	68 - 70	71 - 73	74 - 76	77 - 79			
15	16 1	17 - 19	20 - 22	23 - 25	26 - 28	29 - 31			
	32 2	33 - 35	36 - 38	39 - 41	42 - 44	45 - 47			
3	48 3	49 - 51	52 - 54	55 - 57	58 - 60	61 - 63			
	64 4	65 - 67	68 - 70	71 - 73	74 - 76	77 - 79			

Host: 1 - DF, 2 - GF Sampling Period: 1 = Pre, 2 = 3 day, 3 = 10 day

APPENDIX 8 Three-day Postspray Population Laboratory Form

Block Name__________

Spray__________Check__________

BUDWORM POPULATION DATA

Year__________Region__________Forest__________Host__________

Block No.__________Cluster No.__________Sampling Period__________

Day________Month________Branch: Length______cm Width______cm

Tree	Branch	Larvae	Pupae	Cases	Total	No. Buds	Larvae per 100	Other Larvae	Other Pupae
15 1	16 1	17 - 19	20 - 22	23 - 25	26 - 28	29 - 31			
	32 2	33 - 35	36 - 38	39 - 41	42 - 44	45 - 47			
	48 3	49 - 51	52 - 54	55 - 57	58 - 60	61 - 63			
	64 4	65 - 67	68 - 70	71 - 73	74 - 76	77 - 79			
15 2	16 1	17 - 19	20 - 22	23 - 25	26 - 28	29 - 31			
	32 2	33 - 35	36 - 38	39 - 41	42 - 44	45 - 47			
	48 3	49 - 51	52 - 54	55 - 57	58 - 60	61 - 63			
	64 4	65 - 67	68 - 70	71 - 73	74 - 76	77 - 79			
15 3	16 1	17 - 19	20 - 22	23 - 25	26 - 28	29 - 31			
	32 2	33 - 35	36 - 38	39 - 41	42 - 44	45 - 47			
	48 3	49 - 51	52 - 54	55 - 57	58 - 60	61 - 63			
	64 4	65 - 67	68 - 70	71 - 73	74 - 76	77 - 79			

Host: 1 - DF, 2 - GF Sampling Period: 1 = Pre, 2 = 3 day, 3 = 10 day

Block Name____________________

Spray__________Check__________

BUDWORM POPULATION DATA

Year__________Region__________Forest__________Host__________

Block No.__________Cluster No.__________Sampling Period__________

Day__________Month__________Branch: Length______cm Width______cm

Tree	Branch	Larvae	Pupae	Cases	Total	No. Buds	Larvae per 100	Other Larvae	Other Pupae
15	16 1	17 - 19	20 - 22	23 - 25	26 - 28	29 - 31			
1	32 2	33 - 35	36 - 38	39 - 41	42 - 44	45 - 47			
	48 3	49 - 51	52 - 54	55 - 57	58 - 60	61 - 63			
	64 4	65 - 67	68 - 70	71 - 73	74 - 76	77 - 79			
15	16 1	17 - 19	20 - 22	23 - 25	26 - 28	29 - 31			
2	32 2	33 - 35	36 - 38	39 - 41	42 - 44	45 - 47			
	48 3	49 - 51	52 - 54	55 - 57	58 - 60	61 - 63			
	64 4	65 - 67	68 - 70	71 - 73	74 - 76	77 - 79			
15	16 1	17 - 19	20 - 22	23 - 25	26 -28	29 - 31			
3	32 2	33 - 35	36 - 38	39 - 41	42 - 44	45 - 47			
	48 3	49 - 51	52 - 54	55 - 57	58 - 60	61 - 63			
	64 4	65 - 67	68 - 70	71 - 73	74 - 76	77 - 79			

Host: 1 - DF, 2 - GF   Sampling Period: 1 = Pre, 2 = 3 day, 3 = 10 day

APPENDIX 10 Western Spruce Budworm Defoliation Survey Data Form

Year ______ (1-2) T ______ R ______ S ______ Date ______ Crew Name ______

Region ______ (3-4) Forest ______ (5-7) Host ______ (8-9) Unit ______ (10-11) Cluster ______ (12-13)

Survey Type ______ (14) Opt. 1 ______ (15-) Opt. 2 ______ ( ) Opt. 3 ______ (-20)

TREE	BRANCH	DEFOLIATION 1/	TREE AVERAGE 2/	COMMENTS
(21) 1	1	(22-24)		
	2	(25-27)		
	3	(28-30)		
	4	(31-33)		
(34) 2	1	(35-37)		
	2	(38-40)		
	3	(41-43)		
	4	(44-46)		
(47) 3	1	(48-50)		
	2	(51-53)		
	3	(54-56)		
	4	(57-59)		

TOTAL: ______

1/ Defoliation = Total of ratings from 25 shoots per branch

2/ Tree Average = $\frac{\Sigma \text{ Defoliation}}{4}$

Average percent defoliation (cluster) = $\frac{\text{tree average}}{3} \cdot 12.5 =$ ______ %

APPENDIX 11 Western Spruce Budworm Egg Mass Survey Data Form

Year ________ (1 - 2) T ______ R ______ S ______ Date ____________ Crew Name ____________________

Region ________ (3 - 4) Forest ________ (5 - 7) Host ________ (8 - 9) Unit ________ (10 - 11) Cluster ________ (12 - 13)

Survey Type ________ (14) Opt. 1 ________ (15 -) Opt. 2 ________ (- 20)

TREE	BRANCH	* LENGTH (cm)	* WIDTH (cm)	** AREA (m^2) X.XXX	NEW EGG MASSES				OPTIONAL USE	
					NUMBER	1/ NO. ROWS	ROW 1/ LENGTH (mm)	UN 1/ HATCHED EGGS		
(21) 1	1	(22 - 24)	(25 - 27)	(28 - 32)	(33 - 35)	(36 - 38)	(39 - 41)	(42 -)	(43 -)	(- 50)
	2	(51 - 53)	(54 - 56)	(57 - 61)	(62 - 64)	(65 - 67)	(68 - 70)	(71 -)	(72 -)	(- 79)
(21) 2	1	(22 - 24)	(25 - 27)	(28 - 32)	(33 - 35)	(36 - 38)	(39 - 41)	(42 -)	(43 -)	(- 50)
	2	(51 - 53)	(54 - 56)	(57 - 61)	(62 - 64)	(65 - 67)	(68 - 70)	(71 -)	(72 -)	(- 79)
(21) 3	1	(22 - 24)	(25 - 27)	(28 - 32)	(33 - 35)	(36 - 38)	(39 - 41)	(42 -)	(43 -)	(- 50)
	2	(51 - 53)	(54 - 56)	(57 - 61)	(62 - 64)	(65 - 67)	(68 - 70)	(71 -)	(72 -)	(- 79)

Cluster Average

Egg Mass/m^2 ____________

$$\text{Egg mass}/m^2 = \left[\sum_{\text{Tree}}^{3} \sum_{\text{Branch}}^{2} \left(\frac{\text{egg mass/branch}}{m^2/\text{branch}} \right) \right] \Big/ 6$$

1/ Data to be taken on 1 egg mass/branch

* Length, width - completed in field by branch measurment.

** Area - completed in lab by grid method, record to 3 decimals.

[illegible]

STATE OF IDAHO

DEPARTMENT OF LANDS
PAYETTE LAKES AREA OFFICE
P.O. Box 951, McCall, Idaho 83638

TO: FOREST LANDOWNERS IN ADAMS AND VALLEY COUNTIES

SUBJECT: WESTERN SPRUCE BUDWORM: A MAJOR PROBLEM IN ADAMS AND VALLEY COUNTIES

Defoliation of trees by the western spruce budworm has reached epidemic levels on portions of federal, state and private lands in Adams and Valley Counties where over 500,000 acres are currently infested. The western spruce budworm affects grand fir (white fir), Douglas-fir and Engelmann spruce.

Western spruce budworm caterpillars feed mainly on the current years foliage, consequently, an infestation must continue for 3-4 years to cause growth impact as needles can be retained by host trees for 7-8 years. The effect of feeding is seen as an overall ghostly cast in the forested lands under attack.

Indications are that the epidemic will continue and those areas already affected can expect mortality to increase with the major impact being a decrease in economic, aesthetic and recreation values.

Land managers are currently examining alternatives available to counteract losses due to western spruce budworm. These include the long term methods of altering stand composition to favor less susceptible species and management to promote thrifty, rapidly growing stands. Short term chemical control by aerial spraying of budworm populations is also a technique being studied. Seven-4-oil is registered and was satisfactorily used to kill budworm in Washington and Maine in 1976. Orthene, an approved agricultural chemical, has also been used successfully on the western spruce budworm.

A major spruce budworm control project will be considered for 1978 depending on the results of fall 1977 evaluations and public involvement. Project costs for private property will be paid with state insect and disease control funds as provided under Section 38-408 of the Idaho Code.

Your comments on the budworm problem will be appreciated. Public meetings will be held in Cascade on March 17, 1977 at the Cascade School House at 7:00 P.M.; at McCall on March 18, 1977 at the Payette National Forest Supervisor's Office at 7:00 P.M. Direct all correspondence to Area Supervisor, Idaho Department of Lands, P. O. Box 951, McCall, Idaho 83638. All comments should be received no later than March 31, 1977.

FOR THE DIRECTOR

John K. Parker

JOHN K. PARKER
Acting Area Supervisor

This publication reports pilot project results involving pesticides. It does not contain recommendations for their use, nor does it imply that the uses discussed here have been registered. All uses of pesticides must be registered by appropriate State and/or Federal agencies before they can be recommended.

CAUTION: Pesticides can be injurious to humans, domestic animals, desirable plants, and fish or other wildlife—if they are not handled or applied properly. Use all pesticides selectively and carefully. Follow recommended practices for the disposal of surplus pesticides and pesticide containers.

PROTECT

Use Pesticides Safely
FOLLOW THE LABEL
U.S. DEPARTMENT OF AGRICULTURE

Trade names and commercial enterprises or products are mentioned solely for necessary information. No endorsement by the U.S. Department of Agriculture is implied.

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